SURMAN

Design of a reinforced concrete coaling station

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DESIGN OF A REINFORCED CONCRETE COALING STATION

BY

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This is to certify that the thesis of HUGO EWALD SURMAN entitled Design of a Reinforced Concrete Coaling Station is approved by me as meeting this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

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Professor of Civil Engineering.

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HISTORY OF COALING STATIONS

Present methods of coaling locomotives in the United States are the logical accompaniment to the advancement made in the general science of railroading in this country. The primary reasons bringing about effort in this direction are three, namely; reduction of waste, saving of time to locomotives at busy terminals and to fast trains on the line, and reduction of cost of hauling.

Twenty-five or thirty years ago it was said that there was probably no work on American railroads which was done in such a variety of ways as that of handling and supplying coal to locomotives. Nearly every road had its particular method of doing it and this was usually determined by existing conditions, or perhaps tradition. But the railroads soon began to recognize the importance of using improved methods of handling to enable a more accurate account of the fuel consumption of each locomotive to be kept, and to reduce the cost of handling. The best practice, then in use, for the larger points was to take the coal from platforms alongside the track. These platforms varied in storage capacity from 50 to 1,800 tons. Drop bottom buckets, holding from 1,000 to 2,000 pounds and filled by shoveling, were lifted by derrick or crane, and their contents discharged into the tender. The larger platforms had a narrow-gage track and a truck on which the buckets were moved to the cranes. The coal had to be handled a number of times, as it was first shoveled from the cars to the platform, again to the buckets, then moved by hand to the crane, hoisted by hand with the latter, and finally dumped into the tender.

The chief objection to this method was that the cost of handling was too large since most of the work was done by hand.

The rapid growth of railroad transportation required that the coal be delivered to the locomotives more quickly and with a reasonable degree of economy, and a variety of devices of greater or less merit resulted. An early form used on the Philadelphia, Wilmington and Baltimore, now a part of the Pennsylvania System, consisted of an inclined track alongside the main line leading to a shed with pockets for storing the coal. Small iron cars ran on narrow-gage tracks on each side, but at a lower level than the track on which the coal was received. A bridge ran across above, and at right angles to the main line tracks, the narrow-gage cars being run out on this bridge and dumped through suitable openings and chutes into the tenders below. It cost the road only one-fourth as much to handle its coal in this way as by previous methods - buckets and cranes. There was also a great saving in time, engines being able to take coal in two and one-half minutes. This was a big step forward and other roads began to take notice of the fact that their methods of coaling locomotives could be greatly improved upon.

The principle toward which the best practice tended, where the amount of coal handled justified it, was to provide storage for coal in bulk, delivering it to engines by weight or measure from pockets which were at a sufficient elevation to discharge to the tenders by gravity. The Baltimore and Ohio was one of the first to use this form, having the station arranged so that coal could be taken on either side. The coal receiving track was about 35 feet above the ground, and 11 or 12 feet below it was a

platform about 20 feet wide, on which the coal was dumped. On each side of the platform were bins, 10 or 12 feet wide at the top, with bottoms inclined at about 60 degrees from the horizontal. At the lower end of each bin was an apron held up by counterbalance weights when not in use. Each bin was numbered, and four strips were nailed around the inside to denote the amount of coal contained, the levels of these strips indicating 1-1/2, 2, 2-1/2, and 3 tons respectively. In this way a record could be kept of the amount of coal taken by each engine. The platform and bins were not roofed over, the coal being exposed to the elements.

The New York, Lake Erie and Western had designs quite similar in use at this time, differing only in a few details.

In 1885 a committee of the Roadmasters' Association investigated the cost of handling coal by the different methods in use. For handling over platforms of different constructions, the maximum was 30 cents a ton, and the minimum 11 cents, the average being 19.4 cents. For coal chutes, the maximum was 9 cents a ton and the minimum 4.5 cents, the average being 7.4 cents. The average saving in favor of the chutes was, therefore, 12 cents a ton. The time consumed in taking coal from the chutes was one minute, and from other devices 12 minutes - a saving of 11 minutes per engine coaled in favor of the chutes. Where 3000 tons were handled monthly there was a saving in favor of the chutes of nearly $4,500.

Improvements in chutes continued, the effort being to obtain a form that could be operated easily by one man, would have few parts in its construction, and could be repaired at small cost. A chief objection to the earlier forms was that the combination

of pulleys, chains, and balance weights was such as to cause the aprons to close with considerable momentum, racking the entire mechanism, and disarranging the working parts. A change to overcome this consisted in pivoting the apron so as to be self-balancing and discarding the chains and weights. This, however, threw a considerable increased weight and strain on these pivots; also the sides of the apron were liable to be pushed out unless supported. Furthermore, the top of the apron had to be locked to prevent its being blown open by a heavy wind. In 1891 the Susemihl chute was introduced on the Michigan Central. Chains and weights were used, but they were so adjusted that "the outward pull of the top of the apron due to its vertical thrust beyond the pivot was taken exactly for each position of the apron". Among other advantages, no latches were needed, the inner door being kept closed by the apron as it was lowered by means of small segmental castings attached to the lower edge of the inner door, over which the lower edge of the apron rose as it descended. Very little iron was used in these chutes, the total cost of iron being only about five dollars. The total cost per pocket was said to be much less than any form then in use.

Other designs of chutes with balanced aprons were shortly introduced, the object in each case being to have the vertical resultant of the counterweight vary the same as the weight of the apron. In the Williams, White and Company design, the apron arm had fastened to its outer end cast-iron blocks which could be moved forward or backward to adjust the proper balance. A small latch at the top held the apron and was pulled by the fireman when he wanted to take coal. The arm of the apron, in rising, came in

contact with a latch which released the inner or coal door.

The modern method of lifting and transferring the coal by conveyors at lowomotive coaling stations was first used in the early nineties. One of these plants was installed by the National Docks Railway of Jersey City, New York for the joint purpose of coaling locomotives and supplying a boiler house. The coaling track was also the coal supply track. The pit beneath the track had an inclined bottom which slid the coal sideways into an underground pit opposite the center of the structure. The "endless bucket elevator" lifted the coal 39 feet and discharged it into bins at the top, the storage capacity being 200 tons. The elevator was driven by an eight-horse-power vertical engine, had nine inch by twelve inch buckets spaced twelve inches apart, and had a capacity of 85 tons an hour.

As the demand for saving of labor and expense in the handling of fuel for heavy-draft and high-speed locomotives continued, the conveyor method was developed and perfected. At the present time the more complete of such plants are almost automatic in operation, greatly reducing labor cost. The coal, which is stored in large quantities is accurately weighed as it is withdrawn from the pocket, the weight of the draft being automatically registered and printed in triplicate. One of the best examples of a station of this kind was built in 1904 for the Terminal Railroad Association of St. Louis prior to the operating of the World's Fair. This station enabled a large number of locomotives to be cleaned, coaled, watered and sanded at one time. The station was designed and built by the Link Belt Company of Chicago.

THE PRESENT PROBLEM

The problem at hand is that of designing a coaling station for the Big Four Shops located at Urbana, Illinois so that locomotives can be coaled upon leaving the shops for service. The present station at the shops is of timber construction, and this will, supposedly, be replaced by a more up-to-date structure. The capacity of the station is about 100 tons and from 73 to 97 tons of coal are fed to locomotives daily, the number of engines coaled being about 26 per day. Nothing but bituminous coal is used. This fact will very much simplify the design, and besides a saving in the first cost, there will also be a saving in the operation of the plant. The station must be designed for its maximum run and to this must be added a certain percent to allow for future growth.

FUTURE GROWTH OF BIG FOUR

An investigation of the past growth of the Big Four Railroad will now be made - say for the past ten years - and we will assume that the rate of increase for the next ten years will be the same as that of the past ten years. This assumption will give only approximate results, but it will be accurate enough for this purpose. Since the coaling station supplies coal to locomotives on only one branch of the Big Four System, the growth of this particular branch, known as the Peoria and Eastern Railroad, or Line west of Danville.

In Figure 1 is shown the passenger earnings per train mile, the freight earnings per train mile, and the total earnings per train mile for this branch of the Big Four for the years 1895 to

1906 inclusive. The data from which these curves were plotted were taken from the Inter-State Commerce Statistical Reports. The irregularities in the curves are due perhaps to three causes, namely; panics, railroad legislation, and World's Fair years. For example, the passenger and total earnings show a decided decrease for the year 1896 which was probably due to the poor financial conditions in the country about that time. Again, the big drop in freight earnings and the sudden rise in passenger earnings for the year 1904 was probably due to the congestion of passenger traffic during the World's Fair at St. Louis, which made it impossible for the Company to give proper attention to the freight business.

These curves form the basis for estimating what percent should be added to the present capacity of the coaling station in order to meet the demands ten years hence. This does not mean that the life of the station will be only ten years. It will be considerably longer than that; but at the end of ten years, if these assumptions have proven to be correct, and the capacity of the station be too small after that time, then the station can easily be enlarged to meet the increased demand. It would be taking too large a risk to design a coaling station for more than ten years in the future. Conditions may be different by that time. Some railroads are already experimenting with oil as a fuel for locomotives, and the day is not far distant when the coal supply will be extinguished, or better still - when it will be more economical to use some product other than coal as a fuel. We will be safe then, in designing for only ten years in the future.

Going back again to the curves, we find that from 1896 to

1906, the increase in the earnings of the railroad has been about twenty percent. Adding twenty percent to the maximum output of coal per day at the present time, we get about 120. That is, if 97 tons of coal per day are required at the present time, we will be required to supply 120 tons per day ten years from now. The coaling station, then, will be designed for 120 tons per day capacity.

REINFORCED CONCRETE vs. OTHER TYPES

Having decided on the capacity of the station, we must now determine what material to use for construction - whether steel, timber, or concrete. Steel structures are not much used for coaling stations. They are expensive in first cost and the gases from the locomotives causes the steel to deteriorate quite rapidly. The dust from the coal coming in contact with the steel also causes the steel to deteriorate. About the only advantage claimed for steel over concrete is the fact that steel structures are easier and quicker to erect. A steel structure, therefore, will not be further considered and the discussion reduced to timber vs. concrete.

The total capitalized cost of a timber structure and for a concrete structure will be compared. For this purpose the formula

$$S = C + \frac{O}{r} + \frac{C'}{(r+1)^n - 1} \quad *$$

may be used; where S = total capitalized sum, C = first cost of structure, O = operation and maintenance expenses, r = rate of interest, C' = cost of renewal, assumed to be equal to the first cost, and n = life of struc-

* Taken from Public Water-Supplies by Turneaure and Russel.

ture in years.

Table 1 gives the operating costs of different types of locomotive coaling plants. The data was collected by the committee on buildings, American Railway Engineering Maintenance of Way Association and the table taken from the Engineering News, Volume 59, page 415. All of the stations are of timber construction. From this table, the operation and maintenance expenses can be computed. These two items amount to about $1800 per year. For a concrete structure, the maintenance expense will be considerably less than that of a timber structure - say $1500 for operation and maintenance.

The first cost of a concrete structure is about fifty percent more than that of a timber structure. Taking $8000 as the first cost of a concrete structure, we would have $5333 as the first cost of a timber structure. The rate of interest will, of course, be the same in the two cases, and will be taken at four percent. The life of the concrete structure will be taken as twenty years and the timber structure as fifteen years.

Substituting these values in the above formula, we get the following for the total capitalized sum for the two structures:-

Concrete structure,-

$$S = 8000 + \frac{1500}{0.04} + \frac{8000}{(1 + 0.04)^{20} - 1}$$

$$= \$52,275.00$$

Timber structure,-

$$S = 5333 + \frac{1800}{0.04} + \frac{5333}{(1 + 0.04)^{15} - 1}$$

$$= \$57,000.00$$

This shows that although the concrete structure is higher in first cost, it would prove more economical in the end.

Even if the total capitalized sum required for the concrete structure had proved to be larger than for the timber structure, there are several good reasons why concrete should be used. The insurance charges are about four times as great for timber as for reinforced concrete. This difference in insurance amounts to about fifteen percent of the first cost of construction. Locomotive coaling stations, if constructed of timber, are subject to unusual fire risk. Firemen are careless in cleaning fires in the neighborhood of the structure, and the dried timbers, with deposits of pulverized coal, assure a furious blaze once a fire gets a foothold. Reinforced concrete structures are also superior to timber structures as regards permanence and strength, thus reducing the maintenance expenses to practically nothing.

These conditions have led to the construction of many reinforced concrete structures, even though the initial cost is higher than for timber. The coaling stations which have thus far been constructed of reinforced concrete have given entire satisfaction.

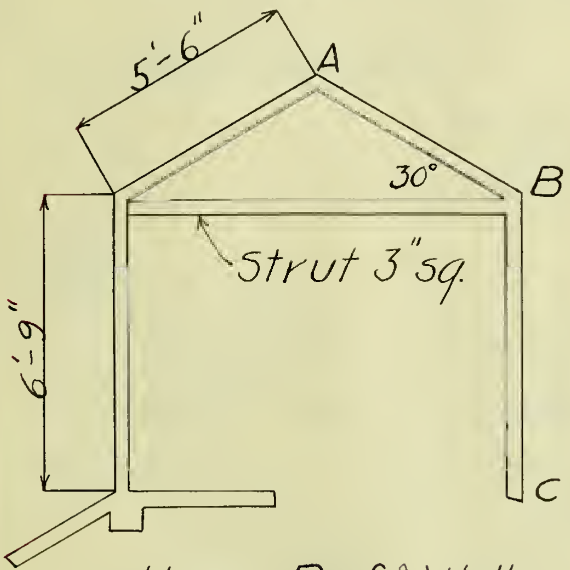
The coaling station for the Big Four Shops in Urbana will be constructed of reinforced concrete.

DESIGN OF STRUCTURE

In the following design the compressive strength of concrete will be taken as 500 pounds per square inch, and the tensile strength of steel as 16,000 pounds per square inch. In designing the different parts of the structure, reference was made to Turneaure and Maurer's Principles of Reinforced Concrete Construction. and Ketchmn's Walls, Bins, and Elevators.

Roof A - B.

The roof will be constructed of reinforced concrete, expanded metal being the reinforcing material. A section 12 inches wide will be considered as acting as a simple beam.



Upper Roof & Walls

Length = 5' - 6"

f_c = 500 pounds square in.

f_s = 16,000 pounds sq. in.

From curves on page 277, Turneaure and Maurer's Principles of Reinforced Concrete Construction, it is found that for the above values of f_c and f_s, p = 0.005, K = 0.32, and j = 0.89.

Load = Snow load + Wind load + dead load.

$= 1.0 \times 5.5 + 30 \times 5.5 \times .866 + 165$

= 360 pounds.

$$M = \frac{Wl}{8}$$

$$= \frac{360 \times 5.5 \times 12}{8}$$

$$= 2970 \text{ lb. in.}$$

$$bd^2 = \frac{M}{f_s p j}$$

$$= \frac{2970}{96000 \times 0.005 \times 0.89}$$

$$= 41.8$$

$$d^2 = \frac{41.8}{13}$$

$$= 3.48$$

$$d = 1.87 \text{ in. (Say 2 in.)}$$

Area of reinforcement

$$= 0.005 \times 2 \times 12.$$

$$= 0.12 \text{ square inches (Use expanded metal)}$$

Member B - C.

This member, or side wall will be designed in two ways - first as a simple beam, and second as a column. The design which gives the larger section will be used.

Considering it as a simple beam, the maximum load will be due to the wind pressure, which will be taken as 30 pounds per square foot.

$$\text{Length} = 6' - 9''.$$

$$\text{Total Load} = 6.75 \times 30$$

$$= 202 \text{ pounds.}$$

$$M = \frac{Wl}{8}$$

$$= \frac{202 \times 6.75 \times 12}{8}$$

$$= 2050 \text{ lb. in.}$$

$$bd^2 = \frac{M}{f_s p j}$$

$$= \frac{2050}{16000 \times 0.005 \times 0.89}$$

$$= 28.8$$

$$d^2 = 2.38$$

$$d = 1.55 \text{ in. (Say 1-3/4 in.)}$$

Considering the wall as a column, the total load would be the load transferred to it by the roof above, plus the dead load.

$$\text{Total load} = 360 \times 148$$

$$= 508 \text{ lb.}$$

$$P' = f_c A \quad 1 + (n - 1)\,p \quad * \qquad n = 15$$

$$508 = 500\,A \quad 1 + (15 - 1)\,0.005$$

$$A = 1.0 \text{ square in.}$$

This gives a thickness of only a fraction of an inch as against 1-3/4 inches when considered as a beam.

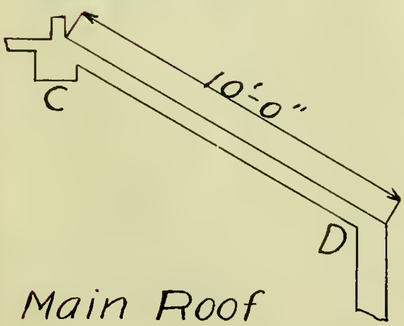
Use thickness 1-3/4 in.

$$\text{Area of steel required} = 1.75 \times 12 \times 0.005$$

$$= 0.105 \text{ sq. in.}$$

Use expanded metal.

Roof C - D.



A section 12 inches wide will be considered as acting as a simple beam. The total load for this section will be due to the wind, snow, and dead loads. The wind load will be taken as 30 pounds per square foot, the snow

*Turneaure and Maurer.

load at 10 pounds per square foot, and the dead load, which is not yet known, will be estimated.

$$\text{Span} = 10' - 0''$$

$$\text{Total load} = 30 \times 10 \times .5 + 10 \times 10 + 500$$

$$= 750 \text{ lb.}$$

$$M = \frac{Wl}{8}$$

$$= \frac{750 \times 10 \times 12}{8}$$

$$= 11230 \text{ lb. in.}$$

$$bd^2 = \frac{M}{f_s p j}$$

$$= \frac{11230}{16000 \times 0.005 \times 0.89}$$

$$= 151.7$$

$$d^2 = \frac{151.7}{12}$$

$$= 12.7 \text{ square inches.}$$

$$d = 3.56 \text{ in. (Say 3-3/4 in.)}$$

Area of steel $= 3.75 \times 12 \times 0.005$

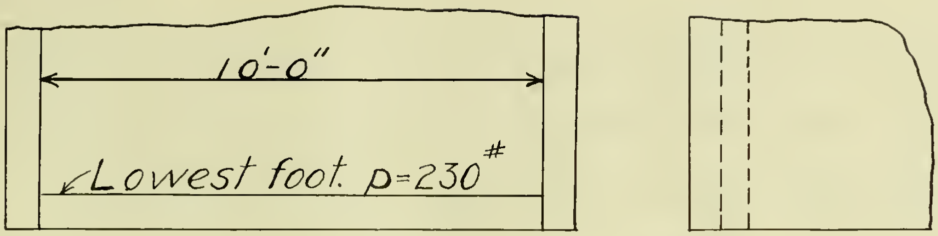
$= 0.225$ square inches.

Use expanded metal.

Bin Wall.

The side walls of the bin will be designed on the basis of the computed lateral pressure exerted by bituminous coal weighing 47 pounds per cubic foot. From table XXIV p. 119 (Ketchmns' Walls Bins, and Elevators) the pressure on the lowest foot, for a depth of coal of 12 feet is 230 pounds. Taking the bottom strip one

foot wide, a simple beam is to be designed that will carry a load of 230 pounds per foot.



Bin Wall.

Span of beam = 10' - 0"

$$M = \frac{Wl^2}{8}$$

$$= \frac{230 \times 10^2 \times 12}{8}$$

$$= 34500 \text{ lb. in.}$$

$$bd^2 = \frac{34500}{16000 \times 0.005 \times 0.89}$$

$$= 486.0$$

$$d^2 = \frac{486}{12}$$

$$= 40.5 \text{ sq. in.}$$

$$d = 6.36 \text{ in. (Say 6-1/2 in.)}$$

$$\text{Area of steel} = 6.5 \times 12 \times 0.005$$

$$= 0.33 \text{ sq. in.}$$

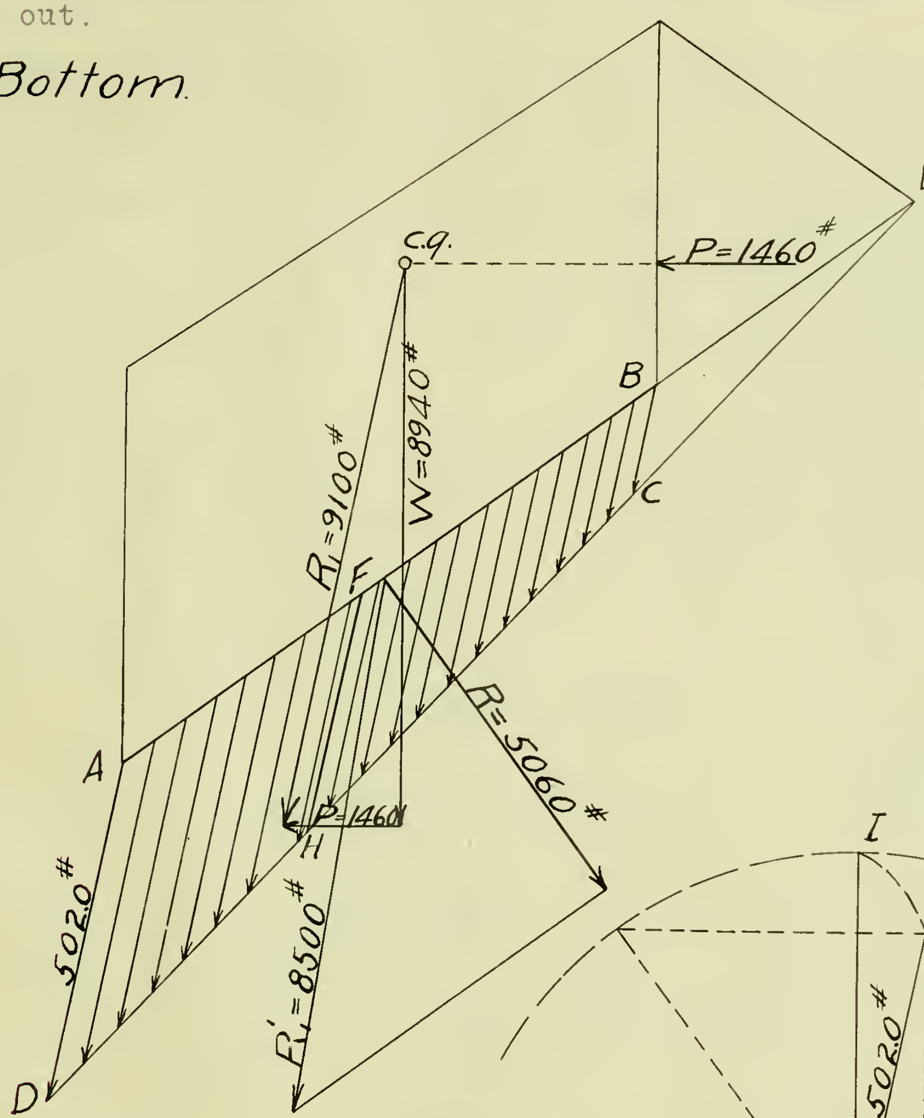
3/8 inch square rods, spaced 5 inches apart will be used.

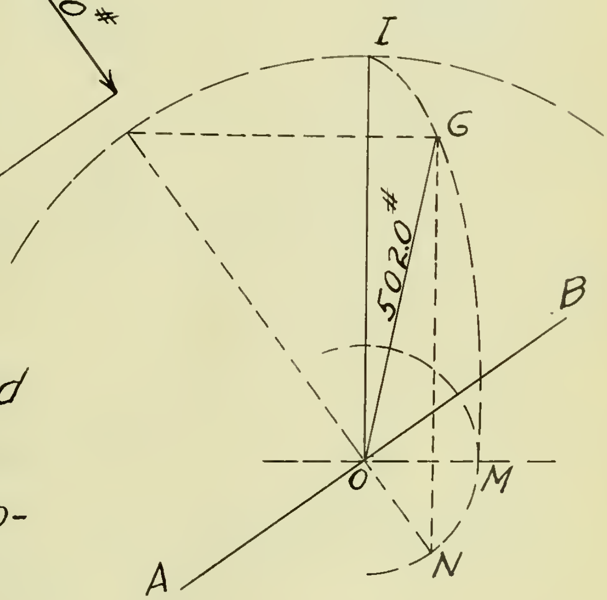
Since the pressure on the lowest foot is the greatest, this section as just designed will be safe if used all the way up. There would be a small saving of material if the wall were stepped off and made thinner at the top. This saving, however, would

be counter-balanced by the additional cost in constructing forms for the "stepped" wall. The wall will be made the same thickness all the way up.

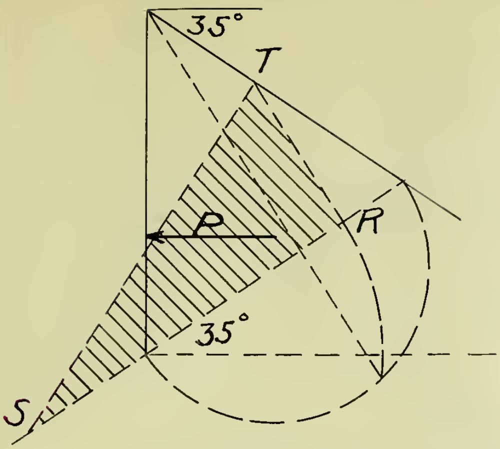
The end wall will be projected six inches out from the front wall and the reinforcing metal extended three inches into the end wall. This will bind the walls together and keep them from being pushed out.

Bin Bottom.





Diagrams showing method of obtaining pressure on bin bottom. Theory obtained from Ketchum.



$$P = \Delta STR \times w$$
$$= \frac{5.0 \times 10.3 \times 58}{2}$$
$$= 1460^{\#}$$

From the above diagrams, it is found that the total pressure normal to the slab is 5060 pounds. The slab is supported by a beam at the point F, so there are two slabs to design, one 10 feet long and the other 8 feet long. The load carried by the 10 foot slab is represented by the area FBCH. This load is equal to 2050 pounds.

We are now to design a simple beam of 10 foot span having a concentrated load of 2050 pounds at its center.

$$M = \frac{Pl}{4}$$

$$= \frac{2050 \times 10 \times 12}{4}$$

$$= 61500 \text{ lb. in.}$$

$$bd^2 = \frac{M}{f_s p j}$$

$$= \frac{61500}{16000 \times 0.005 \times 0.89}$$

$$= 865$$

$$d^2 = 72.1$$

$$d = 8.5 \text{ in.}$$

The load carried by the 8 foot slab is represented by the area AFHD and is equal to 3010 pounds.

$$M = \frac{Pl}{4}$$

$$= \frac{3010 \times 8 \times 12}{4}$$

$$= 72300 \text{ lb. in.}$$

$$bd^2 = \frac{72300}{16000 \times 0.005 \times 0.89}$$

$$= 1015$$

$$d^2 = 84.6$$

$$d = 9.2 \text{ in.}$$

Since there is very little difference in the depth of the slab in the two designs made, the slab will be made the same thickness throughout - say 9-1/2 inches.

Area of steel required

$$= 9.5 \times 12 \times 0.005$$

$$= 0.570 \text{ inches.}$$

Use 1/2-inch square rods spaced 5 inches apart.

Columns.

There are 16 columns in all and these support the weight of the entire structure, including the weight of the coal in the pockets and the weight of the machinery. The weight of the structure itself is found by computing the weight of each member separately and is found to be 583,200 pounds. This result was obtained by considering concrete as weighing 150 pounds per cubic foot, and steel as 490 pounds per cubic foot. The weight of coal when the pockets are full is 120 tons, or 240,000 pounds. The weight of

the machinery will be assumed as 30,000 pounds. The total weight on the 16 columns will then be 653,200 pounds.

Total load for one column is $\frac{653,200}{16}$ = 40,800 pounds.

Let A = total cross-section of column.

p = ratio of steel area to total area.

f_c = stress in concrete.

n = ratio of moduli of steel and concrete at the given stress, $= \frac{E_s}{E_c}$.

P' = total strength of a reinforced column for the stress f_c.

f_c = 500 lb. per sq. in. p = 0.01

n = 15 P' = 40800 lb.

$P' = f_c A \; 1 + (n - 1) p$

$40800 = 500 A \; 1 + (15 - 1) 0.01$

A = 71.7 sq. in.

Use 10 in. x 10 in. columns.

Area of steel.

$A_s = 10 \times 10 \times 0.01$

= 1.0 sq. in.

Use 4-1/2 in. sq. rods.

Design of I-beam for receiving hopper.

Space of beam is 27 feet.

The maximum moment was computed by the use of the engine diagram for Cooper E 50 loading and found to be 519,000 lb. ft.

$$S = \frac{Mc}{I}$$

Try a 24 in. - 80 lb. I-beam.

c = 3.5 I = 42.86 A = 23.32 sq. in.

Allowable fibre stress = 16,000 lb. per sq. in.

$$S = \frac{519000 \times 12 \times 3.5}{42.86}$$

= 509,000 pounds.

$$\text{Required area} = \frac{509000}{16000}$$

$= 31.8$ sq. in. I-beam is too small.

Try a 24 in.-100 lb. I-beam.

$c = 3.627$ $I = 48.56$ $A = 29.41$ sq. in.

$$S = \frac{519{,}000 \times 12 \times 3.627}{48.56}$$

$= 465{,}000$ pounds.

$$\text{Required area} = \frac{265{,}000}{16{,}000}$$

$= 29.02$ sq. in.

Use a 24 in.- 100 lb. I-beam.

Foundation.

The bearing upon the soil must be investigated to see whether or not it is safe.

The bearing area of the foundation is 33 x 35-1/2 = 1170 square feet.

The total load on the soil includes the weight of the superstructure, foundation and engine load. This total load is equal to 1,493,800 pounds, or 747 tons. The actual bearing on the soil in tons per square foot is then $\frac{747}{1170} = 0.638$. Soil, such as exists in this locality has a bearing value of about 4 tons per square foot, so the above bearing area is amply safe.

D E S C R I P T I V E

The coaling station just designed will be briefly described.

In general the station consists of two elevated coal pockets

having a capacity of 60 tons each. From a study of the drawing, it will be seen that the coal is brought to the pocket on a center track and dumped through 13 by 20 foot track hopper into a reciprocating feeder which delivers it into a steel bucket elevator, and which in turn carries it above for distribution into the pockets. The two gates above can be opened and closed at will and coal dumped into either end of the pockets. Coal is fed to engines through undercut hinged gates two on either side of the station. A gasoline engine operates the conveying machinery.

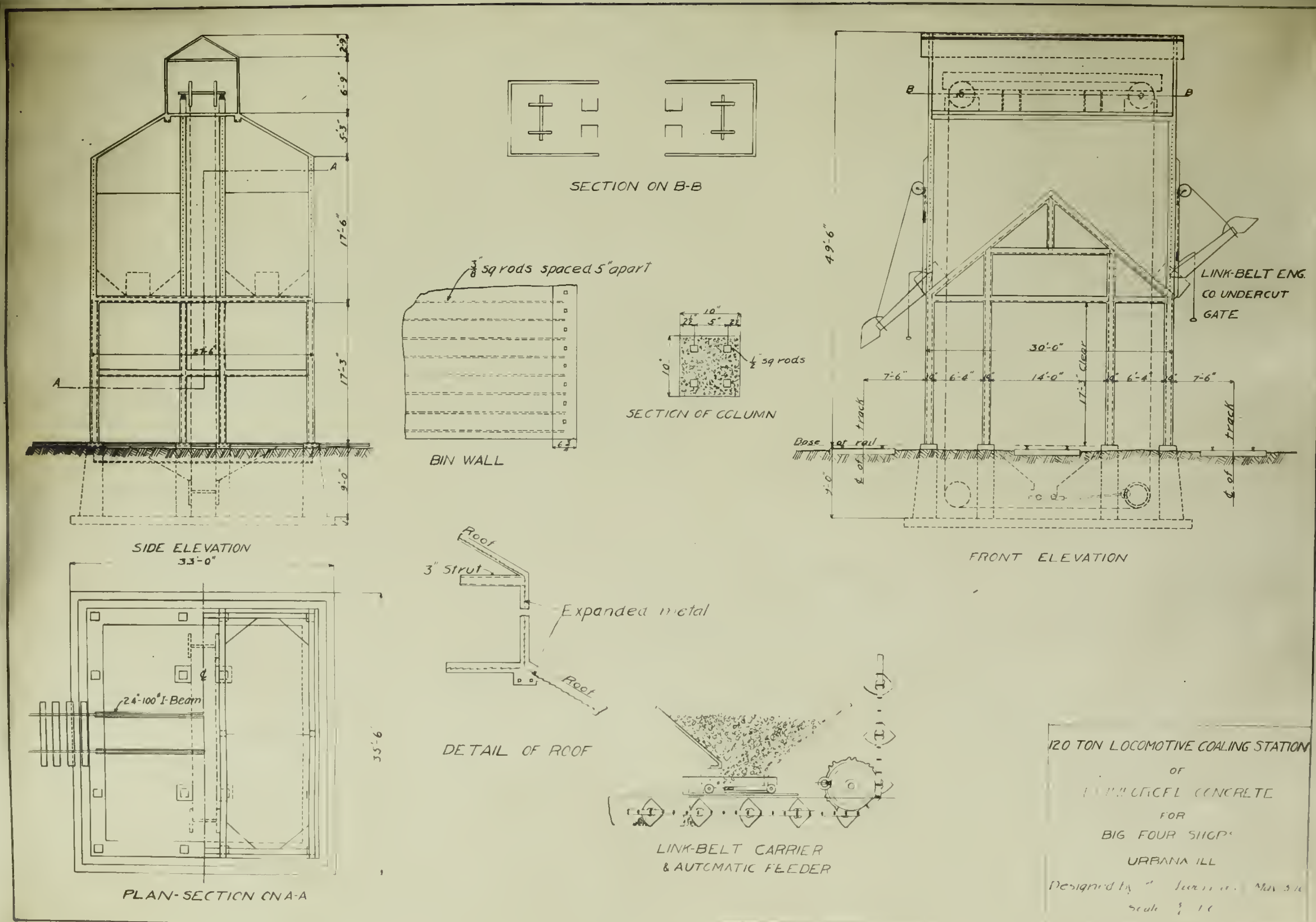

SIDE ELEVATION
33'-0"
PLAN-SECTION ON A-A
24"-100# I-Beam
SECTION ON B-B
3/8" sq rods spaced 5" apart
BIN WALL
SECTION OF COLUMN
1/2" sq rods
DETAIL OF ROOF
Roof
3" Strut
Expanded metal
LINK-BELT CARRIER
& AUTOMATIC FEEDER
FRONT ELEVATION
LINK-BELT ENG.
CO UNDERCUT
GATE
30'-0"
14'-0"
17'-3" Clear
49'-6"
Base of rail
℄ of track
120 TON LOCOMOTIVE COALING STATION
OF
CONCRETE
FOR
BIG FOUR SHOP
URBANA ILL

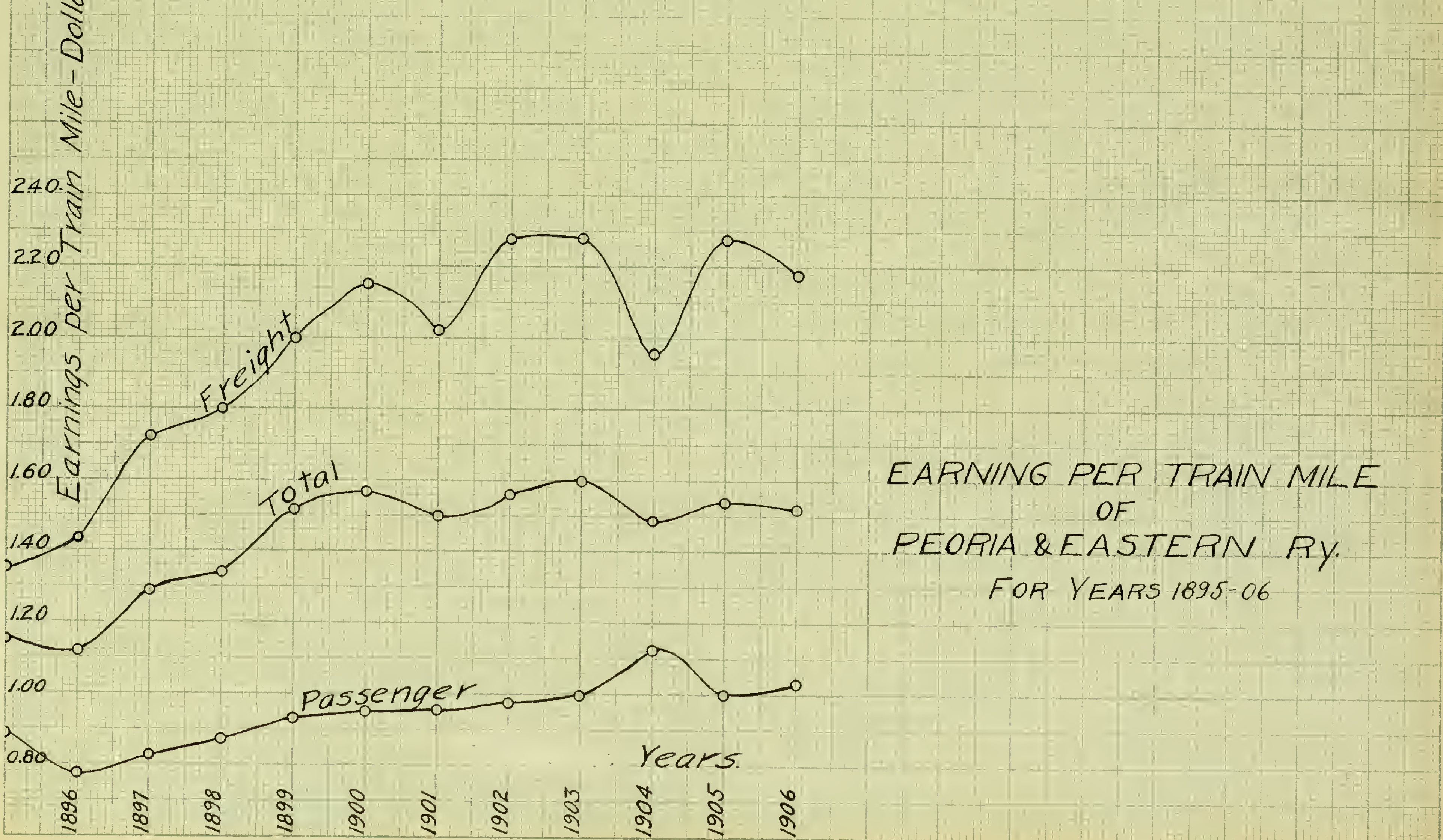
Table No. 1

Operating Costs of Locomotive Coaling Plants.

	Trestle with elevated bins. Small dump cars unloaded by shovel. Williams White type.			High trestle with self clearing cars delivering directly into storage bins.				High trestle with power operated incline.			Locomotive Crane.	Mechanical plant with elevating and conveying machinery.			Mechanical plant with inclined belt conveyor.		
	1	2	3	1	2	3	4	1	2	3	1	1	2	3	1	2	3
Months covered by data	9	–	–	10	1	1	9	3	–	1	24	6	1	–	10	12	3
No. of stations averaged	4	5	1	6	2	17	1	1	5	55	3	1	3	4	4	1	1
Tons handled per day	235	133	13	305	370	440	67	264	166	88	192	165	147	345	280	127	218
Int. & depreciation cts.*	0.8	1.0	1.7	0.5	1.2	0.8	2.3	1.7	2.7	2.7	1.5	3.7	2.5	1.8	1.7	3.2	33
Operation cents.	10.3	11.3	20.6	3.1	6.1	3.6	2.8	3.5	5.1	7.0	3.9	2.7	3.7	2.4	2.7	4.3	3.1
Maintenance cents.	0.5	0.5	2.2	0.5	0.6	0.4	0.1	0.8	1.3	0.9	0.5	1.0	1.0	0.5	0.5	0.6	0.5
Total operating costs per ton	11.6	12.8	24.5	4.1	7.9	4.8	5.2	6.0	9.1	10.6	5.9	7.4	7.2	4.7	4.9	8.1	6.9

*For interest and depreciation 10% of the original cost of the plant was used regardless of the type.

Figure 1.


EARNING PER TRAIN MILE
OF
PEORIA & EASTERN Ry.
FOR YEARS 1895-06
Earnings per Train Mile - Dollars
240.
220
2.00
1.80
1.60
1.40
1.20
1.00
0.80
Freight
Total
Passenger
Years.
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906